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Herbicides and the Soil Fauna

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The literature on the effects of herbicides on the soil microflora is now abundant. In some cases it was found that weedkillers have a toxic effect, as i. e. TKhA, PKhF, IFK and chlorates, but, in general, it can be said that they do not suppress the vital activity of soil micro-organisms. KLYUCHNIKOV and PETROVA (1960) in a chernozem repeatedly treated with 2,4-D, 2 M—4 Kh and fuel kerosene did not notice changes in the number of bacteria in the rhizosphere of oak seedlings, and only a decrease in the number of actinomycetes, with changes on the specific composition of fungi. Increasing concentrations of 2,4-D affect the growth, dehydrogenase activity and nitrogen-fixing power of Azotobacter (LENHARD 1959). On the other side, it is known that soil bacteria can neutralize herbicides (see BROWN and MITCHELL 1948, CRAFTS and DREVER 1960, VERONA 1958, WOODFORD 1960).

In the case of the macrofauna, WEBER (1953) reported no harmful effect of the herbicide "U 46", except small injuries to earthworms. UHLEN (1953) says that earthworms are not affected in their number and distribution. The same happened with micro- and mesofauna, as reported by STEINBRENNER et al. (1960). The use of Simazin and W 6658 produces a slight increase in the population of Collembola and a smaller one in Acarina and Nematoda. However, the difference has no statistical significance compared with that of the untreated soils. The same was stated by BAUDISSIN (1952) using the sodium salt of 2,4-D. Apparently, the only animals inhibited by 2,4-D are soil Protozoa, and this consequently produces a rise in the number of bacteria (ILIN, 1961).

The comparatively small number of references on the possible influence of weedkillers on the soil micro- and mesofauna, with specific reference to springtails (Collembola), moved the authors to try experiments using sodium salt of MCPA acid, and butylic ester of 2,4-D acid (Esso No. 10 and Shell No. 40). For this purpose eight micro-plots were taken on a garden turf, with a total surface of 56 m². Garden soil densely covered with gramineae was used to prevent indirect influence of herbicides. The lack of latifoliae avoids the enrichment of litter by dead leaves which, as it is well proved, increases the population of soil fauna, especially microarthropods. Plots Ns. 1, 3, 4, 7 and 8 were not treated and were used as blanks.

On the 19. IX. 1960 sodium salt of MCPA acid was put in plot 2 in a proportion of 4 liters/Ha., and on the 26. X. 1960 a 10 times in excess the normal dose (20 liters/Ha.) of Esso No. 10[1]). In plot 5 the same preparation (Esso No. 10) was used in the proportion of 2 liters/Ha. Plot 6 was treated with Shell No. 40 in the same proportion of the latter, on the 26. X. 1960. Those preparations of 2,4-D were used because they are especially indicated for garden and golf turfs.

1) Esso Herbicide No. 10 is a preparation of 40% butylic ester of the 2,4-D acid, equivalent to 31.6% of 2,4-D acid. Shell No. 40 contains 40% of the butylic ester equivalent to 33.5% of 2,4-D.

Six days after, 23 soil samples of $10 \times 10 \times 6$ cm. were taken, eight of which corresponded to blanks, and put in a Berlese-Tullgren battery prediously described (Rapoport 1959). The extraction period was 15 days, and the mean weight of samples, at the end of it, was of 1010.2 g. The 25. II. 1961 the same operation was repeated taking 24 samples, nine of them corresponding to the blanks. The almost complete disappearance of the soil fauna during the hotest months of the season prevented us from taking samples between both dates. Results can be compared in tables I and II respectively.

Samples were grouped here trying to keep the topographical order in which they were taken. In table I it is clearly seen that the population density increases at the right, especially from sample 18 to 23. This increase is marked by the collembolan insect *Hypogastrura manubrialis* and the Acari. Fortunately it did not complicate the statistical analysis since the plot treated with Shell No. 40 could be compared with the sample blanks 14, 15, 22 and 23.

The procedure for obtaining the value F was the analysis of variance for subsamples with different number of individuals as developed by Snedecor (1948). The value of t was obtained by applying the method for determination of significance between means of small samples (Paterson 1939).

Samples taken six days after treatment

MCPA and Esso 10 in excess (samples 1 to 5). $\bar{x} = 446$ microarthrop. per sq. dm.
blanks (samples 6 to 9, 15 and 16). $\bar{x} = 478.3$
$F = 0.266$
The table value, for $n_1 = 1$ and $n_2 = 9$ degrees of freedom and $p = 0.05$, is 5.12

Esso 10 (samples 10 to 14). $\bar{x} = 631.2$
blanks (samples 6 to 9, 15 and 16). $\bar{x} = 478.3$
$F = 0.126$
The table value, for $n_1 = 1$, $n_2 = 9$ and $p = 0{,}05$, is 5.12

Shell 40 (samples 17 to 21). $\bar{x} = 1603.6$
blanks (samples 15, 16, 22 and 23). $\bar{x} = 2197.6$
$F = 0.028$
The table value, for $n_1 = 1$, $n_2 = 7$ and $p = 0.05$, is 5.59

Samples taken four months after treatment

MCPA and Esso 10 in excess (samples 1 to 5). $\bar{x} = 276.2$
blanks (samples 6 to 11 and 22 to 24). $\bar{x} = 508.5$
$F = 0.659$
The table value, for $n_1 = 1$, $n_2 = 12$ and $p = 0.05$, is 4.75

Esso 10 (samples 12 to 17). $\bar{x} = 353.8$
blanks (samples 6 to 11 and 22 to 24). $\bar{x} = 508.5$
$F = 0.332$
The table value, for $n_1 = 1$, $n_2 = 13$ and $p = 0.05$, is 4.67

Shell 40 (samples 18 to 21). $\bar{x} = 558.5$
blanks (samples 6 to 11 and 22 to 24). $\bar{x} = 508.5$
$F = 0.018$
The table value, for $n_1 = 1$, $n_2 = 11$ and $p = 0.05$, is 4.84

Hence, it can be concluded that in no case can significant differences be observed between the soil fauna of plots treated and not treated with herbicides. This was also confirmed by comparing the significance between means (t) of treated plots with blank samples taken in the more proximate neighborhood.

The remarkable change undergone by the soil population during the summer 1960—1961 is noteworthy. The figures corresponding to the dominant species of Table I, *Hypogastrura manubrialis*, fell to those of the almost rarest ones in Table II. Another dominant species, *Ceratophysella armata* var. *communis*, dissappeared completely, as also happened with *Sminthurinus mime*, *Isotomina thermophila*, *Drepanura* sp. and *Isotomiella minor*. These species were replaced by *Proisotoma minuta*, *Entomobrya* sp. and *Folsomina onychiurina*, and the dominance being given by *Folsomides americanus*. The mean density of the total fauna also fell from 115,048 to 42,733 per sq. m.

The variation among group proportions is

2. XI. 1960	%	25. II. 1961	%
Collembola	59.1	Acari	40.8
Acari	30.9	Collembola	29.1
Symphyla	4.5	Homoptera	19.5
ants	1.9	ants	6.6
Protura	1.2	Corrodentia	1.7
other groups	2.4	other groups	2.3

Summary

Three plots of a garden turf soil were treated with (a) sodium salt of the MCPA acid and a ten times normal dose of butylic ester of the 2,4-D acid (Esso 10), (b) Esso 10, and (c) Shell 40 in the proportions normally used for garden and golf turfs. 23 and 24 soil samples of 10×10×6 cm. were taken 6 days and 4 months respectively after the treatment. The statistical analysis showed no significant differences between treated and untreated samples. It can be concluded that 2,4-D and MCPA weedkillers do not affect in appreciable manner the total density of soil micro-arthropods.

Zusammenfassung

Drei Parzellen eines Garten-Rasen-Bodens wurden unterschiedlich behandelt: (A) mit Natron-Salz der MCPA-Säure und einer zehnfach normalen Dosis eines Butyl-Esters der 2,4-D-Säure (Esso 10), (B) Esso 10 und (C) Shell 40 in der Menge, wie sie für Garten- und Golf-Rasen normalerweise verwendet wird. 23 und 24 Bodenproben (von 10×10×6 cm) sind 6 Tage bzw. 4 Monate nach der Behandlung entnommen worden. Die statistische Analyse zeigte keine Differenzen zwischen den behandelten und unbehandelten Proben. Es kann daraus geschlossen werden, daß 2,4-D- und MCPA-Unkrautvertilger die absolute Besatzdichte der bodenbewohnenden Klein-arthropoden nicht nennenswert beeinflussen.

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